

Appl. No. 10/731,496
Amdt. dated August 22, 2006
Reply to Office action of May 23, 2006

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DESCRIPTION OF THE EMBODIMENTS

[0023] The orienter 10 of the present invention is attached to the drilling motor assembly 20 portion of a drilling tool assembly 100. The motor assembly 20 portion is used primarily for turning a rotating drill bit 130. By repositioning the orienter assembly 10 of the present invention to a different location within the drilling tool assembly 100 than is found in prior art drilling tool assemblies, the construction of the drilling tool assembly is simplified and its overall length is reduced. This simplified construction and reduced length makes a drilling tool assembly 100 incorporating the orienter 10 of the present invention easier to use by eliminating the logistical issues and special job site planning considerations associated with more complex, longer length prior art drilling tool assemblies.

[0024] As may be seen in Figure 1, the orienter 10 of the present invention is used in a drilling tool assembly 100 which is mounted on the end 115 of a length of coiled tubing 110. The coiled tubing 110 is typically stored on a mobile platform 200 at the earth's surface. An injector assembly 140 connected to the mobile platform 200 grasps the coiled tubing 110 and exerts linear force thereon to move it through a subterranean borehole.

[0025] As may be seen in Figure 2, the disclosed orienter 10 forms a part of a drilling tool assembly 100. The drilling tool assembly 100 is designed and provided with the necessary hardware well known to those of ordinary skill in the art for mounting on the end of coiled tubing 110. Beginning at the end 115 of the coiled tubing 110 which connects to the drilling tool assembly 100, the drilling tool assembly

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100 includes a steering tool assembly **120** for monitoring and tracking position of the drilling tool assembly **100** in the borehole **B** as it is being drilled. Mounted next to the steering tool assembly **120** is the drilling motor or mud motor assembly **20**. The drilling motor or mud motor assembly **20** is a hydraulic motor which produces rotational power or torque from the flow of drilling fluid or drilling mud through fluid flow passages within the motor assembly **20**. It is typically the motor assembly **20** which adds the greatest amount of length to the drilling tool assembly **100**.

[0026] According to the present invention, the orienter assembly **10** of the present invention is positioned in front of the drilling motor assembly **20**, just behind the rotating drill bit **130**. The orienter assembly **10** includes a housing **30** which may be divided into an upper section **32** and a lower rotatable section **34**. Finally, at the distal end **102** of the drilling tool assembly **100** is the rotating drill bit **130**. It is the rotating drill bit **130** which actually cuts through the soils and the rock to form the subterranean borehole **B**. Linear force transmitted to the drilling tool assembly **100** by the force placed on the coiled tubing **110** by the injector assembly **140**. The linear force moves the rotating drill bit **130** forward as the rotating drill bit **130** cuts through the soil and rock at the drill face at the end of the borehole.

[0027] In Figure 2 the lower rotatable section **34** is held fast; that is, it does not rotate. Accordingly, the fixed bend **36** in the lower rotatable section **34** of the orienter **10** causes the rotating drill bit **130** to form an arcuate segment of the borehole **B**. As shown in exaggerated manner in Figure 2, if the fixed bend **36** is in a substantially vertical plane, the drilling tool assembly **100** will form an arcuate segment of the

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borehole **B** which tracks upwardly to the earth's surface **S**, thereby allowing for removal of the drilling tool assembly **100** from the end **115** of the coiled tubing **110** after the drilling tool assembly **100** exits the borehole.

[0028] In contrast, the lower rotatable section **34**, shown in Figure 3 is not held fast or in a fixed position; instead it is allowed to turn. The turning of the lower rotatable section **34**, to include both the fixed bend **36**, and the lower portion **34**, with respect to the non-rotary housing **22** around the drilling motor **20**, enables the rotating drill bit **130** to cut a straight line segment of a large borehole. The transfer of torque from the drive shaft **24** portion of the drilling motor assembly **20** to the upper section **32** causes the entire lower rotatable section **34** to turn as shown in Figure 3.

[0029] In a macro sense, the housing **30** of the disclosed orienter **10** looks like an extension of the non-rotating housing **22** which surrounds the drill motor **20**. However, housing **30** of the orienter **10** is separate from housing **22**. This separation allows the external, lower rotatable section **34** with a fixed bend **36** to rotate constantly at a minimal rpm while the drill motor assembly **20** causes the rotating drill bit **130** to move straight ahead with an oscillating action and thereby form a straight segment of the borehole **B**, as shown in Figure 3. Disengagement of the mechanical connection between the upper section **32** from the drive shaft **24** portion of the drill motor assembly **20** and the indexing of the lower rotatable section **34** to the desired clock face position has the effect of placing the rotating drill bit **130** in a directional or steering mode as shown in Figure 2 because the fixed bend **36** in the external, lower

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rotatable section 34 does not rotate. However, because the drive shaft 24 of the drilling motor 20 is still connected to the rotating drill bit 130 by a universal joint or flexible coupling 26, the rotating drill bit continues to turn.

[0030] As shown in Figure 4, the necessary drive force or rotational torque which causes the external, lower rotatable section 34 with a fixed bend 36 to turn is obtained from the drive shaft 24 of the drill motor assembly 20. In the preferred embodiment, connection of the external, lower rotatable section 34 with a fixed bend 36 to the drive shaft 24 of the drill motor 20 is accomplished by the use of a mechanical clutch mechanism 40.

[0031] The clutch mechanism 40 may be activated by a variety of different means to include an electrical, hydraulic, or mechanical signal. In the illustrated embodiment, the mechanical clutch mechanism 40 includes a first rotating tapered or wedge section 42 with an internal contact surface 44 which frictionally engages a second rotating tapered or wedge section 46 with an external contact surface 48. The frictional contact between internal surface 44 and the external contact surface 48 is sufficient to transmit rotational torque from the drive shaft 24 to the internal gear assembly 60. Those of ordinary skill in the art will understand that other types of mechanical clutch mechanisms or non-mechanical clutch mechanisms may be used without departing from the present invention. Such other clutch mechanisms may include electrical clutches and hydraulic clutches.

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[0032] In the preferred embodiment, an internal gear assembly 60 within the upper section 32 is used. The internal gear assembly 60 includes a plurality of externally toothed spur gears 62. The rotation of the spur gears 62 causes rotation of the external housing 30 by engagement of a large-internally toothed ring gear 64 with the rotating spur gears 62. The gear ratio between the spur gears 62 and the ring gear 64 provides for a reduction in speed and an increase in torque. The end result is a circular movement of the lower rotatable section 34 including the fixed bend 36 and the rotating drill bit 130 to drill a straight borehole through soil and rocks. Those of ordinary skill in the art will understand that while a simple speed reduction gear train has been shown in the preferred embodiment, other speed reducing or torque mechanisms may be used without departing from the scope of the invention, to include but not limited to a hydraulic drive or a helical actuator.

[0033] To assure proper clock face position of the lower rotatable section 34 with respect to the non-rotating housing 22 surrounding the motor assembly 20 or torque transfer, a set of radially spaced contact points or similar radial position indicating systems, well known to those of ordinary skill in the art, may be used to provide a signal representative of the clock position of the lower rotatable section 34. As the lower rotatable section 34 is selectively rotated or indexed to a desired orientation by the motor 20, a single contact closes a circuit at a location representative of the clock face position of the lower rotatable section 34. The signal is received at the surface using a wireless transmission or a wire line. Knowledge of the clock face position of the lower rotatable section 34 enables the operator to assure that the fixed bend portion 36 of the orienter 10 is properly rotated or indexed to the desired

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orientation to create an arcuate segment of the borehole B which follows along a predetermined path.

Operation

[0034] A still better understanding of the orienter of the present invention may be had by an understanding of its method of operation.

[0035] The system and method of the present invention is part of a drilling tool assembly 100 which typically governs the operation and direction of a rotating drill bit 130. As distinguished from prior art orienters, the orienter 10 is positioned next to the rotating drill bit 130. The combination of the drill bit 130, the orienter 10, and the mud motor assembly 20 is located on the end 115 of coiled tubing 110. Because the orienter 10 has been relocated to a position next to the rotating drill bit 130, it is now in a position where it can use the torque output of the mud motor assembly 20 rather than rely on a separate source of torque or rotary power. Those of ordinary skill in the art will also understand that while the conventional location for the steering tool assembly 120 which provides an indication of tool 100 location behind the motor assembly may be used, a steering tool assembly 150 may also be located inside of the lower rotatable section 34 or ahead of the mud motor assembly 20 as shown in F

igure 5

[0036] The orienter 10 of the present invention may be used with its own indicators to provide position information if necessary or desired. Specifically, the disclosed orienter 10 will be capable of including a radio beacon transmitter 50 for

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wireless or wireline reporting of the position and orientation of the lower rotatable section 34.

[0037] Also, as previously indicated, the disclosed system and method allows for the orienter 10 to be placed ahead of or in front of the mud motor assembly 20. This arrangement simplifies construction and provides easier set up of drilling operations. In addition, this configuration enables the torque provided by the drilling motor 20 to both rotate the lower rotatable section 34 including the fixed bend 36 for either drilling a straight line portion of the borehole B or for rotating the housing to a desired clock face position for drilling an arcuate portion of the borehole B.

[0038] The preferred embodiment of the orienter 10 includes the use of a gear reduction system 60 driven by the output driveshaft 24 of the mud motor assembly 20 to both change the rotary speed and torque provided. The output driveshaft 24 of the mud motor assembly 20, when engaged with the housing 30, rotates the lower rotatable section 34 that contains the fixed bend 36. When desired, the gear reduction system 60 is disengaged from the output driveshaft 24 of the mud motor assembly 20 to cause the rotating drill bit 130 to create an arcuate borehole in a predetermined direction. The gear reduction system 60 can then be re-engaged to provide continuous rotation of the lower rotatable section 34, thereby facilitating drilling a straight segment of the borehole as shown in Figure 3.

[0039] Observers of the entire system will see a large storage and spooling reel 108 containing a sufficient length of a continuous coiled tubing 110 to be injected and

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retracted from the borehole as shown in Figure 1. The coiled tubing 110 is coupled to the storage and spooling reel 108. The spooling reel 108 contains a fluid swivel at its center portion to allow fluids to be pumped through the coiled tubing 110. An electrical wire, for communication of an electrical control signal or providing electrical power, may be inserted through the entire length of the coiled tubing 110 to provide access at the storage and spooling reel 108 for coupling to controls at the earth's surface using an electric swivel. The coiled tubing 110 is injected and retracted (pushed/pulled) by an injector assembly 140 that grasps the coiled tubing 110 and moves it in the desired direction.

[0040] The housing 22 containing the drill motor 20 itself does not contain a fixed bend section. Specifically, the drill motor assembly 20 is a straight mud motor known as a positive displacement motor or "mony" style motor. The drill motor housing 22 abuts the leading end 115 of the coiled tubing 110 and is held in place by the coiled tubing 110 which resists the torque and tensile forces involved in the drilling process.

[0041] Typically, control of the orienter 10 requires communication of an electrical signal. This communication and any power required to actuate the clutch mechanism may be provided by an electrical wireline connection and pathway provided within the entire system. This pathway may either be fully inside the coiled tubing 110 and drilling tool assembly 100 or maintained on the outside of the coiled tubing 110 and drilling tool assembly 100.

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[0042] Alternatively, wireless means may be used for control of the operation of the orienter 10. When a wireless control system is used, a transmitter and receiver may be used to communicate with each other, providing instructions for when to engage and disengage (rotate or go steer) the orienter 10. Such instruction can be implemented by installing a logic assembly in the orienter 10 that receives and sends data back and forth to a transmitter/receiver that is located in the coiled tubing 110 at the leading end of the tubing 105, above the mud motor 20.

[0043] Once the rotating drill bit 130 exits the ground, only the orienter portion 10 of the drilling tool assembly 100 need be pushed further out of the ground. If a back reaming tool powered by the mud motor is to be pulled back through the borehole, only the orienter 10 need be removed from the front of the mud motor assembly 20 to attach the back reamer.

[0044] Critical to the operation of the orienter 10 of the present invention is the amount of torque that is generated by the speed reduction or torque conversion system. In the preferred embodiment, the torque transferred by the internal gear reduction system 60 is determined by the design parameters of the gears 62, 64. To minimize the effect of torque on the gears 62, 64, two functions have been incorporated into the orienter 10. The first function is a built-in slip in the frictional power transfer engagement of the clutch mechanism 40. This built-in slip releases the drive shaft 24 at a given amount of excess torque to prevent damage. The second function is the basic design of the housing. Although it is imperative that the housing be robust enough to withstand the forces and the conditions encountered when drilling a borehole, the

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housing has also been designed to minimize the amount of resistance against the sides of the borehole to prevent a potential lag – which potential lag would be seen as increased torque load in the gear section.

[0045] While the present system and method has been disclosed according to the preferred embodiment of the invention, those of ordinary skill in the art will understand that other embodiments have also been enabled. Such other embodiments shall fall within the scope and meaning of the appended claims.